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Lead Scientist's Report

Summary: This report includes five items: (1) summary of one article from *Nature Climate Change* on predicted precipitation 'whiplash' in California; (2) summary of Operation Baseline Conceptual Framework Workshop; (3) update on the Integrated Modeling Request for Proposals; (4) summary of the panel discussion on invasive weed monitoring and applications of remote sensing; and (5) By the Numbers.

Increasing Precipitation Volatility in Twenty-First-Century California. Swain, Daniel L.; Langenbrunner, Baird; Neelin, J. David; and Hall, Alex. *Nature Climate Change*. April 2018.

Precipitation in California is highly variable over a range of time scales, with large-scale variation across years, seasons, and at shorter time periods. As seen during the transition from extreme dryness between 2012 and 2016 to extreme wetness during the 2016-2017 winter, the state can shift rapidly from drought to flood conditions, a phenomenon referred to as 'precipitation whiplash'. Many studies have examined how climate change might affect California's climate and extreme weather events, with general agreement that changes are likely to occur. However, a cohesive idea about the nature of these changes has yet to surface, and this uncertainty leaves California's water infrastructure highly vulnerable and presents great challenges to water managers.

Researchers from University of California (UC), Los Angeles, the Nature Conservancy, and UC Irvine used a state-of-the-art approach to modeling that incorporates a very large number of model runs and scenarios to provide a clearer picture of how precipitation extremes in California could change over the course of the 21st century. They found that under a business-as-usual scenario for future carbon emissions, the number of extremely wet seasons (similar to the 2016–2017 winter season) in the state is likely to increase by 100–200% over the next century. Further, the occurrence of extremely wet, persistent storm sequences that occur on a shorter time scale, such as those that led to the Great Flood of 1862, could increase by 300–400% by the end of the century. This means that Northern California could experience multiple such events by 2100, with enormous potential impacts on the state. The researchers found that the frequency of extremely dry winters was also likely to increase across California, though not as much wet winters. Finally, precipitation whiplash was predicted to increase by about 25% in Northern California and about 100% across Southern California. All of these results indicate that our already variable climate is likely to become even more variable into the future with business-as-usual climate trajectories, and that the resulting extreme events would have substantial impacts on future water management.

Update on Operation Baseline: Regional San Wastewater Treatment Plant Upgrade Conceptual Model and Management Needs Workshop

Beginning in 2019, the Sacramento Regional County Sanitation District (Regional San) wastewater treatment plant will undergo $1.6 billion in upgrades. These upgrades will substantially reduce total nitrogen levels and alter the chemical form of nitrogen discharged to the Sacramento River. To better understand the effects of these changes on the Delta ecosystem, the Council funded a set of pilot studies, known as Operation Baseline, which includes characterizing some chemical and biological conditions prior to the treatment plant upgrades. In addition to their on-going field work, the Operation Baseline team has developed a

conceptual framework of how the nutrient changes may have far-reaching effects, the related uncertainties, and remaining knowledge gaps.

On May 18, 2018, the Delta Stewardship Council and the San Francisco Estuary Institute hosted a workshop that brought together scientists and managers to present the conceptual framework and discuss how to best link current and future research with management needs related to the wastewater treatment plant upgrade. Representatives from a broad range of agencies and stakeholders were in attendance, including the Central Valley and San Francisco Regional Water Quality Control Boards, the California State Water Resources Control Board, CA Department of Fish and Wildlife, the Interagency Ecological Program, United States Geological Survey, Regional San, Central Contra Costa Sanitation District, and others. The conceptual framework highlights mechanisms that link major management topics (consumptive water use, recreation and navigation, habitat, and the food web) to changes in nutrient concentrations, phytoplankton production, aquatic vegetation, harmful algal blooms, and the microbial community. A series of targeted discussions evaluated the importance, relevance, and feasibility of future research related to these management topics. Workshop attendees agreed that maximizing coordination and analysis across various entities and approaches (including among monitoring, special studies, and modeling efforts) was extremely important.

If you missed the workshop and are interested in providing feedback, please visit the Council's website for the agenda, meeting materials, and survey: http://deltacouncil.ca.gov/event-detail/15633. In addition, a workshop synthesis will be available this summer.

Integrated Modeling Request for Proposals (RFP) update

Better use of modeling that is linked to environmental decision making has been highlighted repeatedly as an important issue in the Delta, and the further development of integrated modeling is a current priority for the Delta Science Program. To facilitate this effort, the Science Program initiated a Request for Proposals (RFP) to compile information on the existing use of models in the Delta, as well as to identify opportunities and constraints for expanded efforts going forward. The Science Program recently reviewed proposals for this RFP and is in the process of finalizing a contract with Tetra Tech to complete the proposed work. A kick-off meeting to initiate work on the project is planned for July. Based on the RFP, the contractor will address a number of key issues to improve the use of integrated modeling within the Delta, including:

- inventorying models suitable for addressing management questions associated with scenario planning and forecasting of alternative futures;
- identifying technological challenges and solutions for model integration, including data gaps;
- identifying best modeling practices; and
- developing a synthesis paper on the state of Delta modeling.

This contractor will work with the Science Program's Integrated Modeling Steering Committee, which consists of model developers and users from agencies and stakeholders across the Delta. This effort will be completed over the coming year, and the synthesis paper will be a key component for enhancing the use of integrated modeling within the Delta.

Panel Discussion on Invasive Weed Monitoring and Applications of Remote Sensing

As part of their on-going review of the Delta monitoring enterprise, the Independent Science Board hosted a panel discussion of potential applications of remote sensing for invasive weed monitoring during their May meeting. Panelists included Dr. Susan Ustin (UC Davis), Eddie Hard (California State Parks Division of Boating and Waterways), Dr. Shruti Khanna (California Department of Fish and Wildlife), Jeff Wingfield (Port of Stockton), and Gina Darin (California Department of Water Resources).

Remote sensing refers to the acquisition of information (typically, some type of imagery) about the Earth without actually physically contacting it. Data are collected using specialized sensors/cameras aboard satellites or aircraft and can identify features of the Earth's surface (e.g., elevation, vegetation, water quality, fire). Remote sensing is a useful method for tracking the spread of invasive plants, including floating and submerged aquatic vegetation, because it allows for monitoring data to be collected rapidly over a large area. An especially sophisticated type of remotely sensed imagery, called 'hyperspectral' imagery, can identify the presence of weeds underwater and distinguish between multiple species of weeds. Remote sensing also has the potential to detect other invasive species, such as the notorious nutria, based on impacts to vegetation.

Panelists reiterated the need for more coordinated remote sensing efforts in the Delta. They highlighted that acquiring suitable data can be expensive, often requiring custom flyovers. For any single agency to bear this cost would be difficult, but if multiple entities pooled resources, it would be more affordable. In turn, with more reliable funding, remotely sensed imagery could be collected more consistently and more frequently—two major challenges regarding the current imaging of the Delta. Finally, panelists agreed that existing monitoring data and projects should be better communicated and shared between groups, as one agency's data may supplement another's efforts. Invasive weeds pose a major threat to the Delta ecosystem, economy, and culture/recreation. If Delta agencies are able to better coordinate their efforts, remote sensing offers a promising method to better monitor invasive weeds in this important system.

By the Numbers

Delta Science Program staff will give a summary of current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

List of Attachments

Attachment 1: By the Numbers (report to be provided at the Council Meeting)

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